This approach requires quantitative factors for hazardous characteristics of individual microorganisms. Hazardous characteristics such as pathogenicity, allergenicity and toxicity were difficult to ascertain. However, some data on the number of organisms required to initiate infection (i.e. the infectious dose), could be obtained from the literature [2].

Quantitative risk assessment is valuable in particular with regard to aerosol transmittable microorganisms. If you know how many infectious doses will be handled at once and you know the air volume and ventilation rate of the room, you can calculate a maximum foreseeable exposure index. By extrapolation, it can be determined if that incident could result in an inhaled amount to produce infection.

Taking into account the risk class of the microorganism and its individual hazardous characteristics, the valuation of risks is the basis for risk management. This includes containment measures designed to prevent or at least minimise releases to the work area and the environment. Dependent on the microorganism, additional personal protection can be achieved via a vaccination.

4 Discussion

Apart from a "less is best" approach aiming at the reduction of volumes and concentrations, improvement can be accomplished by eliminating hazardous microorganisms from the production process. Containment measures for high risk microorganisms are particularly costly in terms of equipment, energy input and the use of hazardous chemicals. When hazardous microorganisms are replaced, certain containment measures may no longer be necessary to maintain adequate protection.

By recombinant cloning, genes of interest can by introduced into a stable, well known production organism. Concomitantly, the yield of the required product, e.g. an enzyme or pharmaceutical, can be increased. Results from this study support the notion that the use of genetically modified microorganisms provides environmental and economic benefits, and can improve the safety of the production process.

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5 References

[1] OECD Ad hoc Task Force on Biotechnology for Clean Industrial products and Processes (1998): Biotechnology for Clean Industrial Products and Processes: Towards Industrial Sustainability. OECD, Paris, France

[2] Collins, C.H. (1993): Laboratory-acquired Infections. Butterworth-Heinemann, Oxford, UK

[3] Lelieveld, H.L.M. and the EFB Working Party Safety in Biotechnology (1996): Safe biotechnology. 7. Classification of microorganisms on the basis of hazard. Appl. Microbiol. Biotechnol. 45, 723-729

[4] Doblhoff-Dier, O.; Huss, S.; Litos, R.; Plail, R.; Unterluggauer, F.; Reiter, M.; Katinger, H. (1991): A modular computer-controlled fermentation pilot-plant. Process Biochemistry 26, 201-207

[5] Vigon, B.W. (1996): Software systems and databases, in: Curran, M.A. (ed.) "Environmental Life Cycle Assessment", McGraw-Hill, New York, NY

Book Reviews

Life Cycle Design for SMEs

Life Cycle Design, A Manual for Small and Medium-Sized Enterprises

Editors: Behrendt, S., Jasch, C., Peneda. M.C., van Weenen, H.
Publisher: Springer Verlag, 1997; 44 Abb., 16 Tab., XV, 191 pages, 705 g Hardcover;
DM 148, US$ 99,95, GBP 57, SFR 135, ÖS 1080,40; ISBN 3-540-62793-6

The many thousands of small and medium-sized enterprises in the European Union are extremely important both economically and socially, because they account for more than 99% of all enterprises and for 65% of all employment and turnover. Environmental management systems and tools may be rather complicated and require well-educated manpower. Therefore, until now only relatively few SMEs have been able to adopt such systems, but both national and international organisations try to help promoting the message and guide the SMEs in a sustainable direction.

One such contribution is this manual for life cycle design which has been developed by a European research team with members from Germany, the Netherlands, Austria and Portugal. The manual is a result of an EU project which ran from April 1995 to April 1996. It is intended to serve as a source of information and ideas for environmental product development and for assisting SMEs in incorporating environmental criteria. It provides guidance at various levels of involvement and for different stages of product development. Further advantages by life cycle design are the potential cost saving and improved productivity due to a better developmental structure.

The book contains a lot of valuable background information about environmental management, legislation, standards and the product development process. The information, however, is related most to German-speaking countries. In addition, the book contains seven actual case examples of products improved by the life cycle design of different companies.

The core of the book is the actual manual with framework and tools showing how life cycle design can be realised. The fundament is checklists, with criteria and A-B-C rating schemes, for each of the following 13 – ecological – principles:

1. Achieving environmental efficiency/optimal function
2. Saving resources
3. Use of renewable and sufficiently available resources
4. Increasing product durability
5. Design for product reuse
6. Design for material recycling
7. Design for disassembly
8. Minimising harmful substances
9. Environmental friendly production
10. Minimising environmental impact of products in use
11. Using environmentally friendly packaging
12. Environmentally friendly disposal of non-recyclable materials
13. Implementing environmentally friendly logistics

The tool is simplified and should be useful for most SMEs, but it still requires more practical experience before a final evaluation of its usefulness is appropriate.

The book is highly recommendable, although some information is now somewhat outdated; for instance, the information about standards and web addresses. There are too many spelling errors of chemical names, and Figure 4.2 on page 38 is not understandable without an explanation.

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